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(54) **LIQUID CRYSTAL DISPLAY PANEL AND METHOD OF MANUFACTURING THE SAME**

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(57) **ABSTRACT**

Disclosed is a liquid crystal display panel which includes a first substrate, a thin film transistor array comprising at least one thin film transistor formed on a first surface of the first substrate, and a second substrate having a first surface facing the first substrate, the second substrate including an antistatic layer on a surface opposite the first surface of the second substrate. Liquid crystal molecules are positioned between the first surface of the first substrate and the first surface of the second substrate, wherein the antistatic layer includes conductive nanowire.

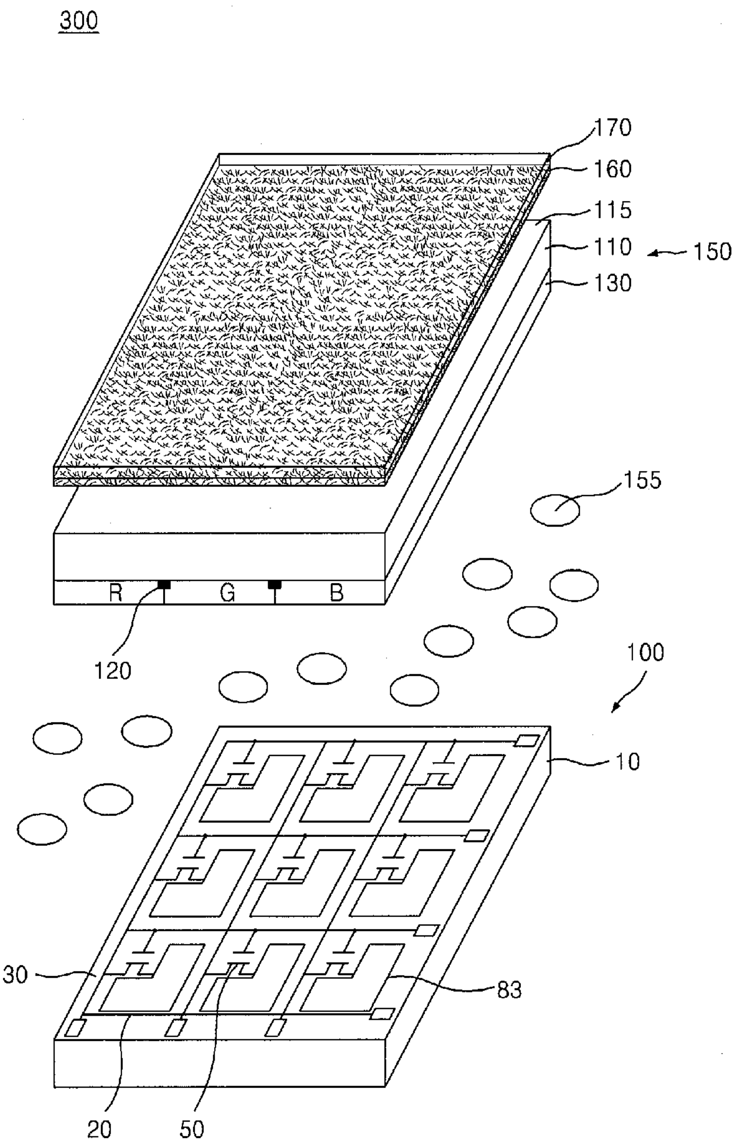


FIG. 1

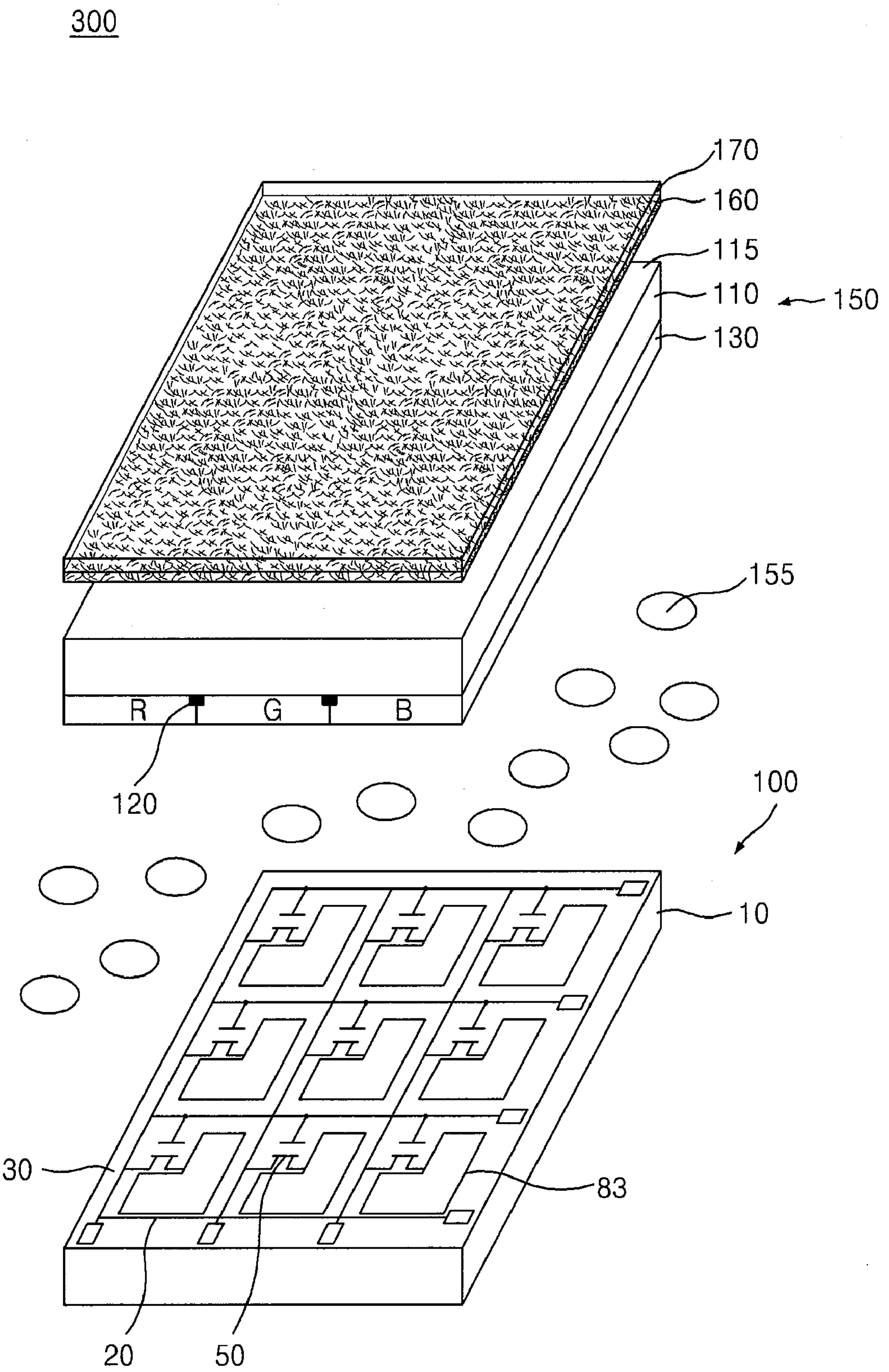


FIG. 2

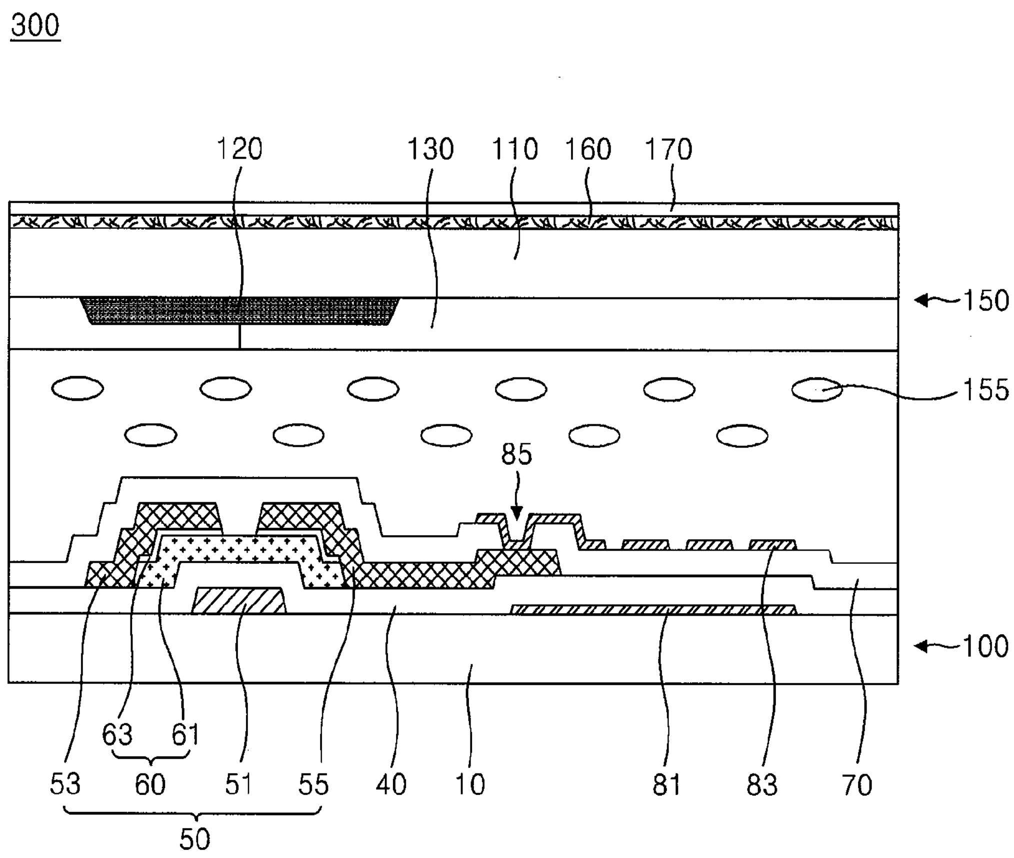

300
120
130
110
160
170
150
155
85
100
63
61
53
60
51
55
40
10
81
83
70
50

FIG. 3

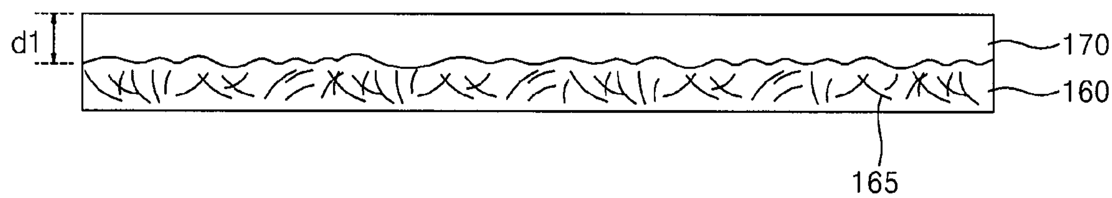

d1
170
160
165

FIG. 4

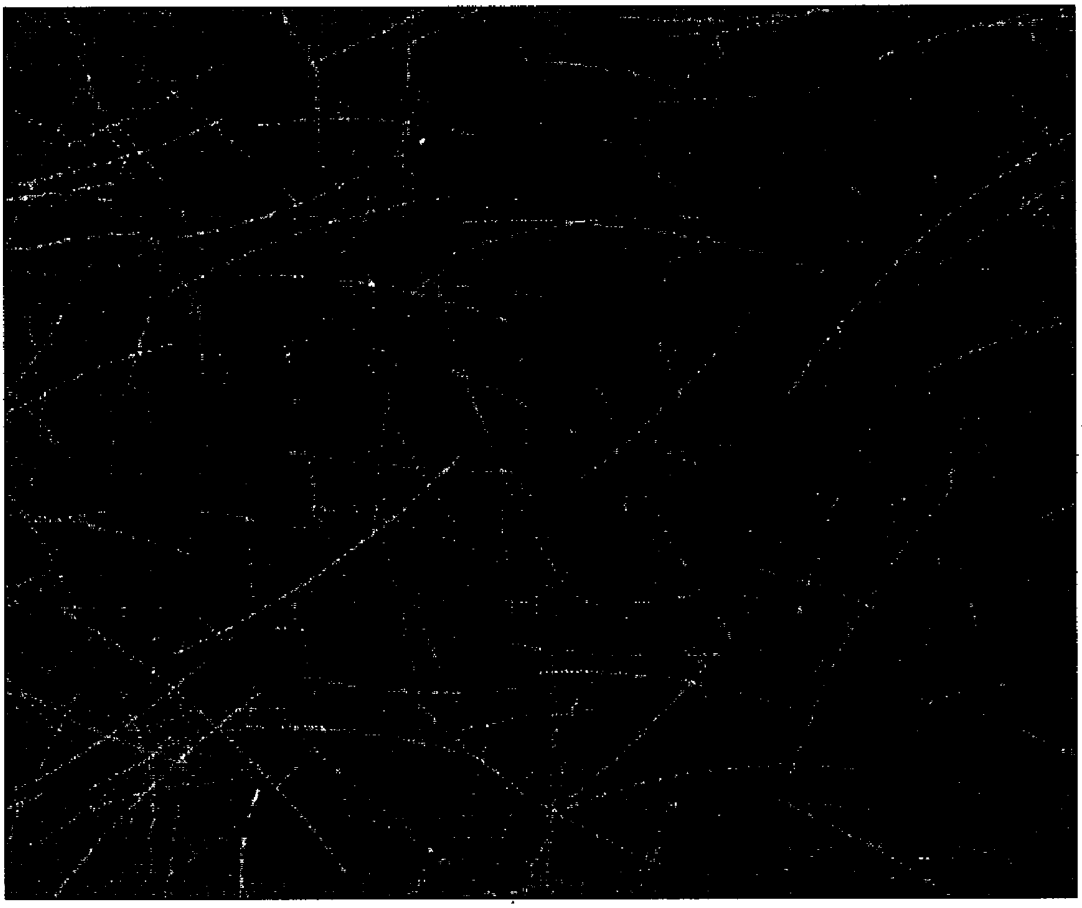


FIG. 5

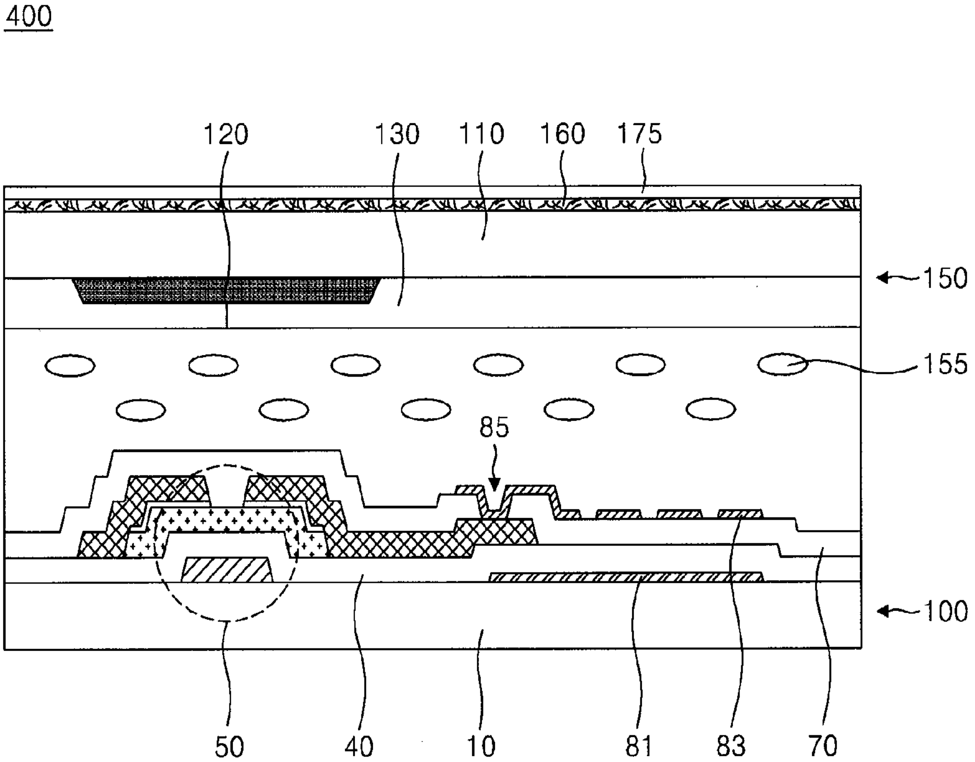

400
120
130
110
160
175
150
155
85
100
50
40
10
81
83
70

FIG. 6

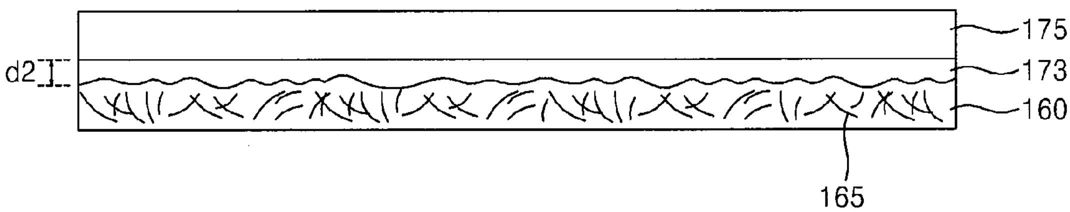

d2
175
173
160
165

FIG. 7

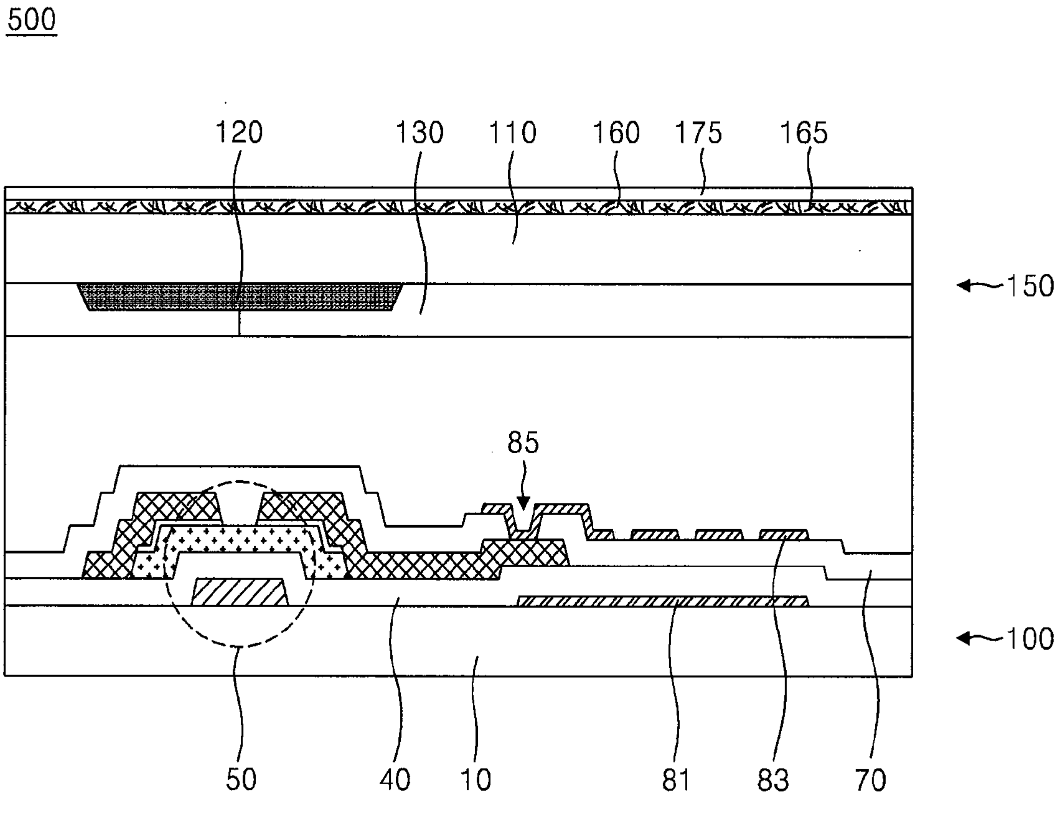


FIG. 8

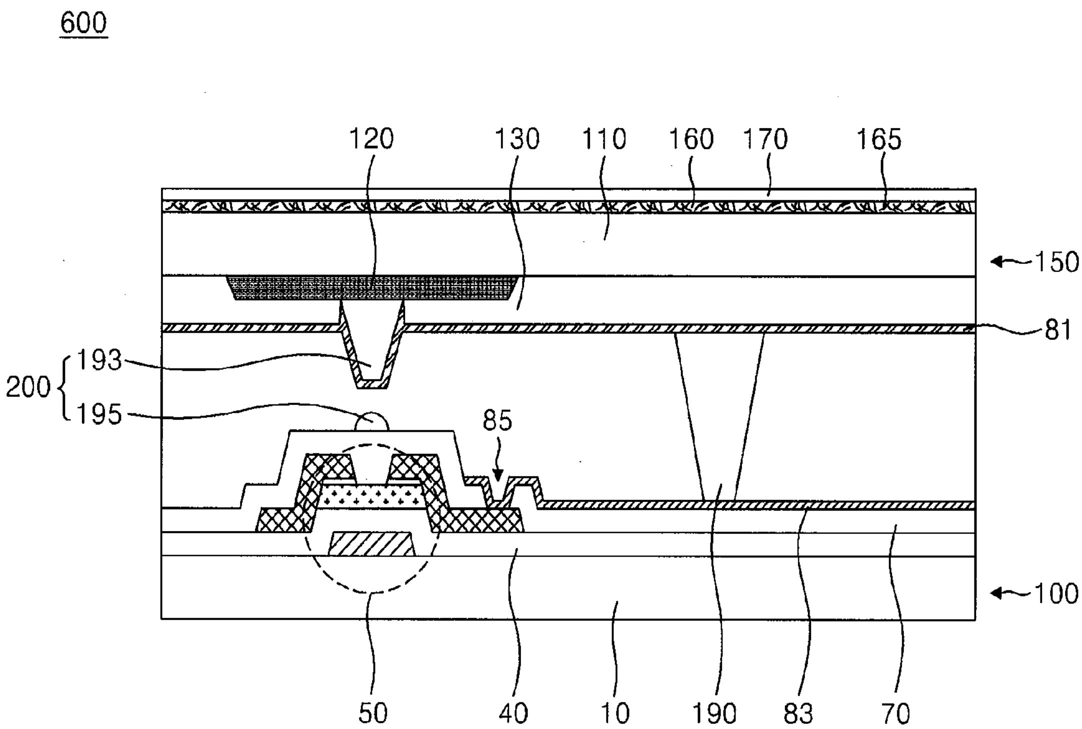

600
120
130
110
160
170
165
150
81
200
193
195
85
50
40
10
190
83
70
100

FIG. 9

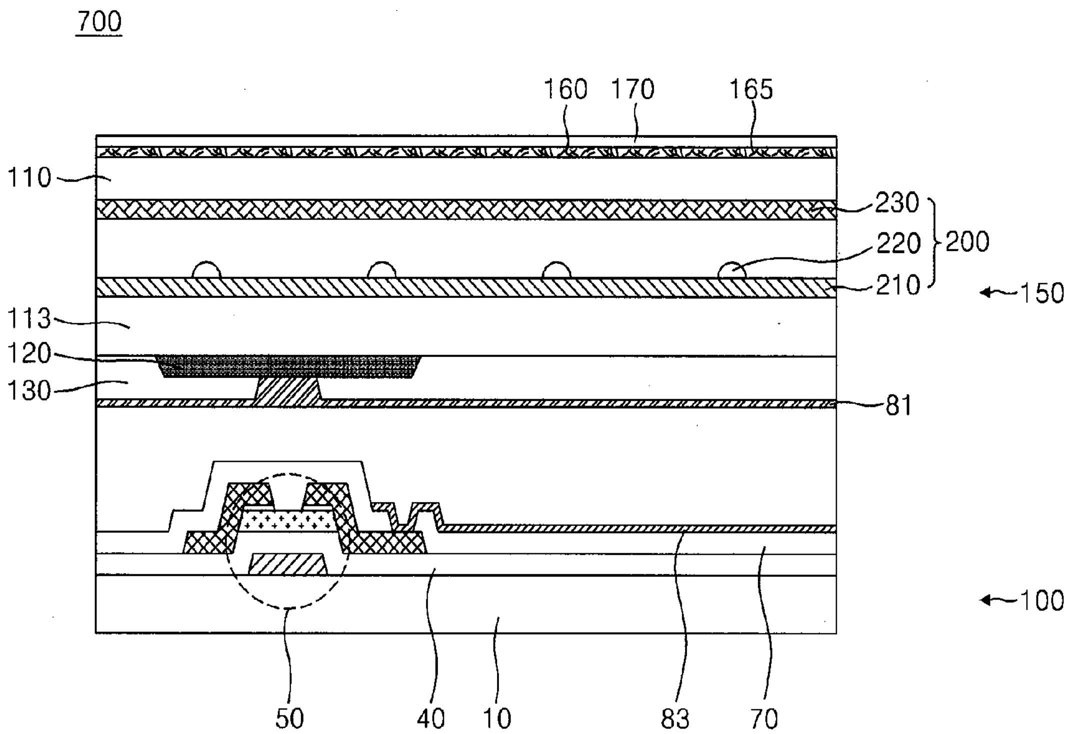

700
160
170
165
110
230
220
200
210
150
113
120
130
81
100
50
40
10
83
70

FIG. 10A

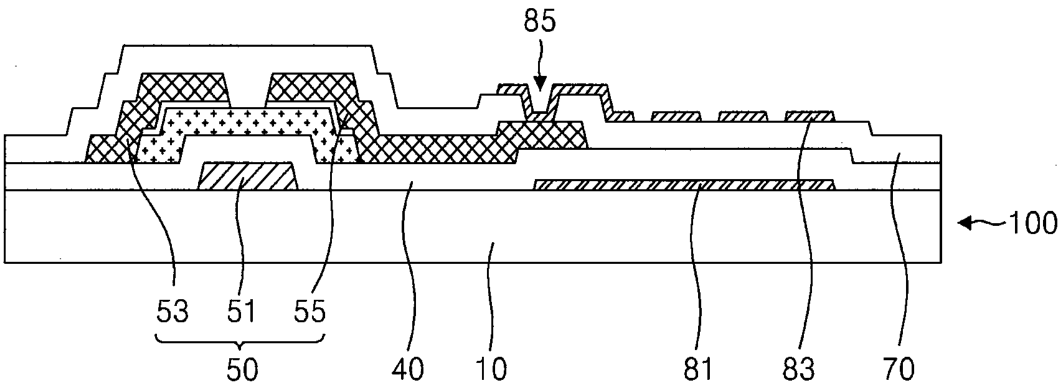


FIG. 10B

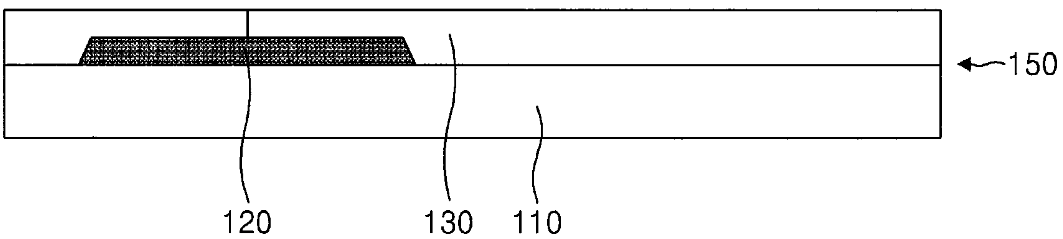


FIG. 10C

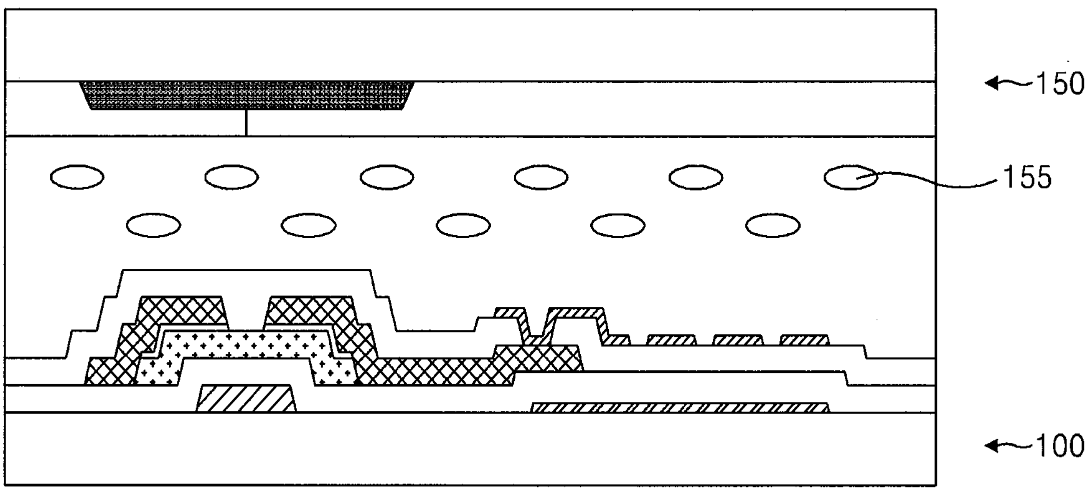


FIG. 11A

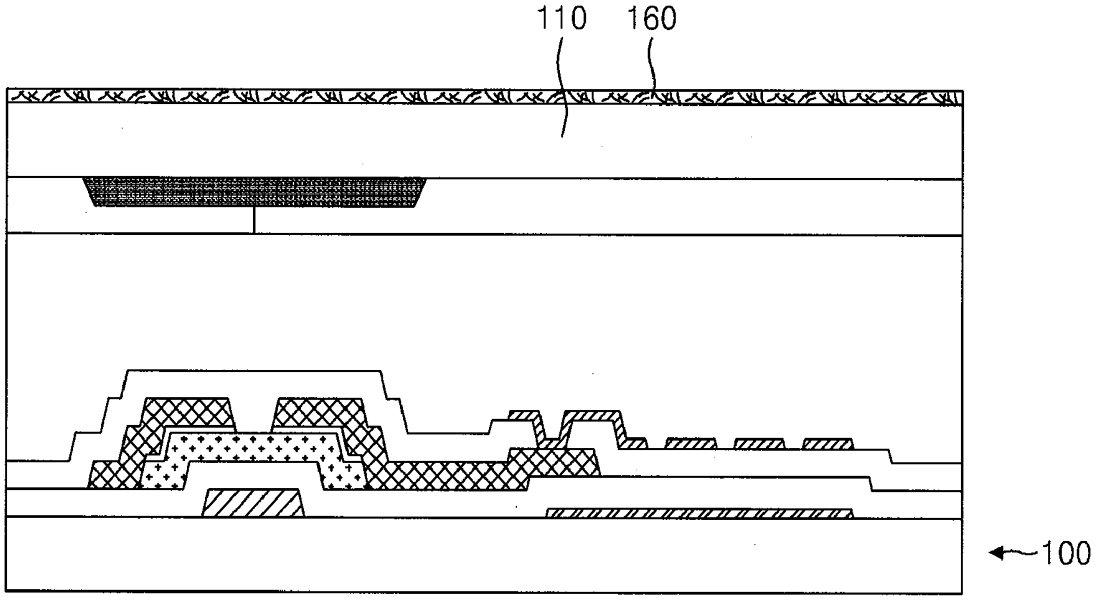


FIG. 11B

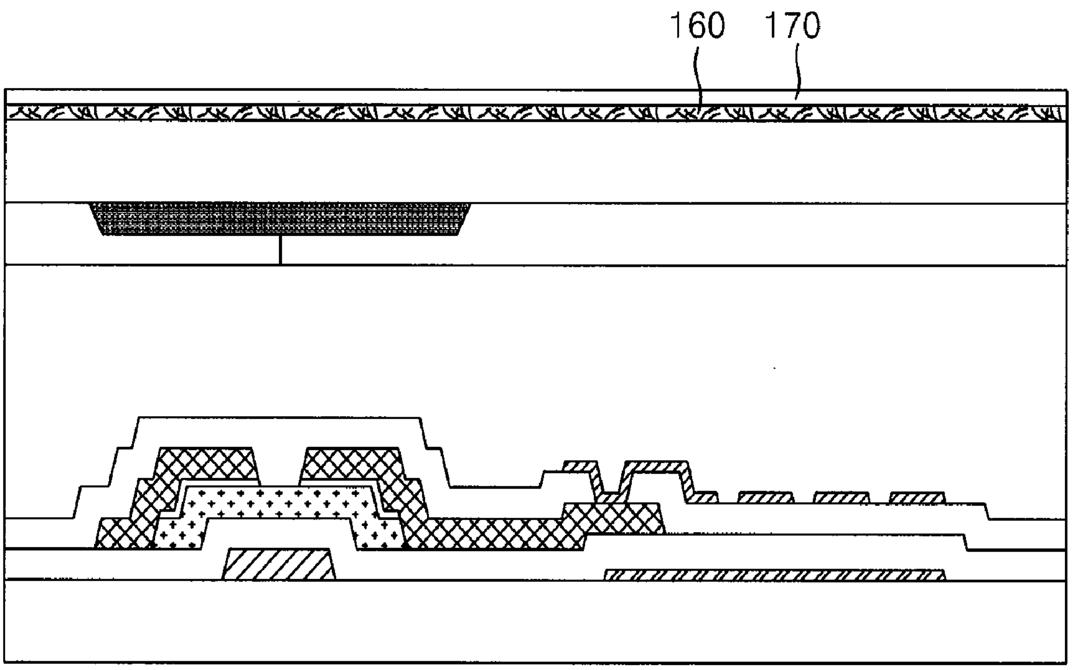


FIG. 12

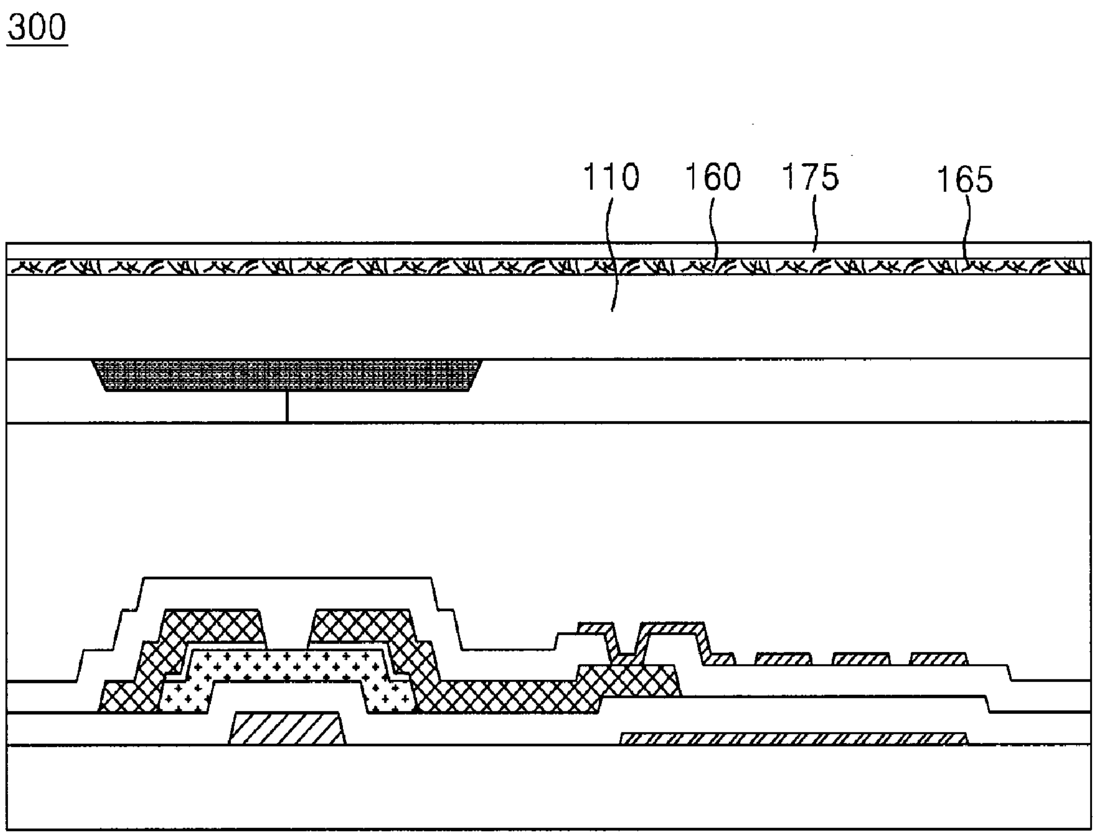
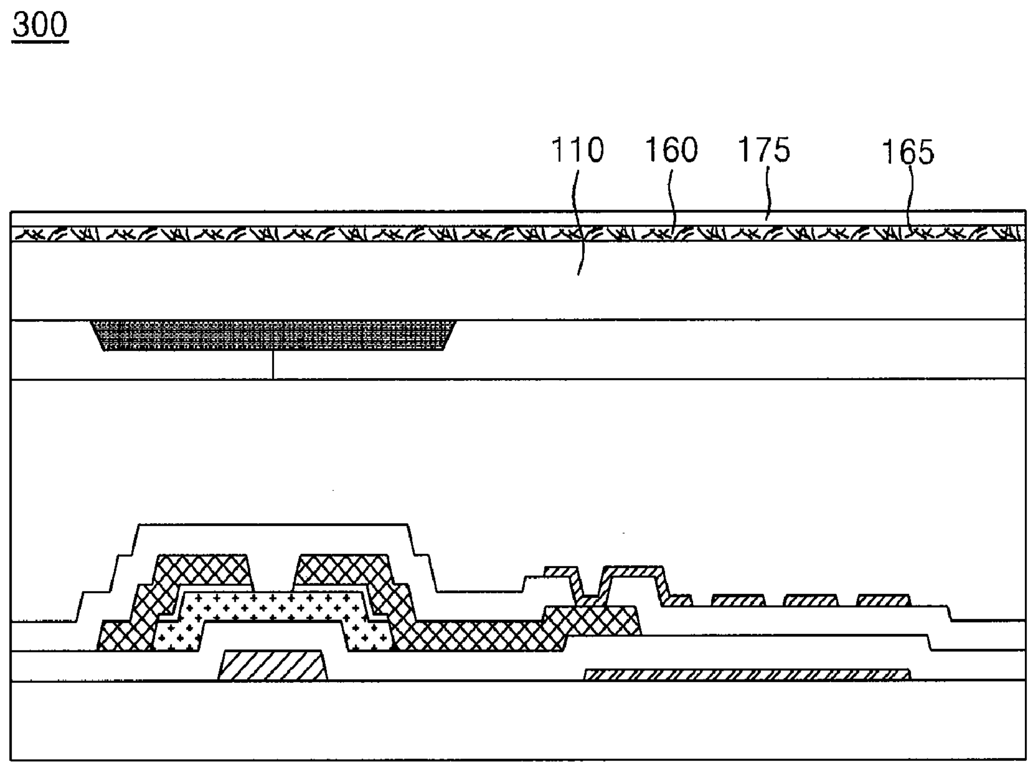


FIG. 13



LIQUID CRYSTAL DISPLAY PANEL AND METHOD OF MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority under 35 U.S.C. §119 to Korean Patent Application No. 10-2007-0085341, filed on Aug. 24, 2007 in the Korean Intellectual Property Office (KIPO), the contents of which are incorporated herein by reference in their entirety.

BACKGROUND

[0002] This disclosure relates to liquid crystal display ("LCD") devices, and more particularly, to a plane-to-line switching mode touch screen panel LCD.

[0003] With the development of the modern information age, LCD devices have received increased attention for use as display devices. Although LCD display devices are typically somewhat more expensive than cathode ray tube display devices, their application range has been greatly extended due to their recognized advantages of being light in weight, slim in size, and low in power consumption. An LCD device displays images by causing liquid crystal cells which are arranged in a matrix shape in a liquid crystal panel to adjust their light transmittance in response to a video signal.

[0004] An LCD device may be classified into an in-plane switching ("IPS") mode LCD device or a plane-to-line switching ("PLS") mode LCD device according to the arrangement of liquid crystal molecules.

[0005] In the PLS mode LCD device, a common electrode and a pixel electrode with an insulating layer disposed therebetween form a fringe electric field in each pixel region and thus liquid crystal molecules disposed between an upper substrate and a lower substrate operate in each pixel region. The PLS mode, however, may be subject to static electricity because electrodes are formed on only one substrate, generating an electric field.

[0006] An LCD device can include a touch display panel through which data is input by pressing a display screen by means of a pen or a finger. However, as a result, the touch display panel can also be easily subject to static electricity.

[0007] To suppress the occurrence of static electricity, an antistatic layer made of indium-tin-oxide ("ITO") is deposited at the back side of an opposite substrate of the LCD panel using the PLS mode and touch screen panel technologies. However, since the ITO used for the antistatic layer is different in deposition conditions from the ITO used for the pixel electrode and the common electrode, it is necessary to additionally manufacture the antistatic layer, which thereby increases costs. Furthermore, because the surface of the ITO used for the antistatic layer is exposed without a passivation layer, scratches may occur and thus defects may be increased.

BRIEF SUMMARY

[0008] In accordance with the exemplary embodiments disclosed herein, an LCD panel and methods of manufacturing the same will save manufacturing costs by means of an antistatic layer using a conductive nanowire, where the antistatic layer is protected from scratching by forming an overcoat layer and a passivation film on the antistatic layer.

[0009] In one exemplary embodiment, a liquid crystal display panel includes: a first substrate; a thin film transistor array comprising at least one thin film transistor formed on a first surface of the first substrate; a second substrate having a first surface facing the first substrate, the second substrate including an antistatic layer on a surface opposite the first surface of the second substrate; and liquid crystal molecules positioned between the first surface of the first substrate and the first surface of the second substrate, wherein the antistatic layer includes conductive nanowire.

[0010] The conductive nanowire may be formed of an electrically conductive material.

[0011] The electrically conductive material may include at least one of gold (Au), silver (Ag), platinum (Pt), palladium (Pd), nickel (Ni), copper (Cu), carbon (C), aluminum (Al), tin (Sn), and titanium (Ti), or a combination of two or more of these materials.

[0012] The liquid crystal display panel may further include an overcoat layer formed on the antistatic layer.

[0013] The overcoat layer may be formed with a thickness of about 1 nm to about 10 μm.

[0014] The overcoat layer may be formed of a transparent synthetic resin.

[0015] The antistatic layer may further include a polymer material.

[0016] The polymer material may be an aqueous polymer material.

[0017] The aqueous polymer material may include at least one of poly(3,4-etylenedioxythiophene), water-dispersive urethane and water-dispersive polyurethane.

[0018] The liquid crystal display panel may further include a protective film on the antistatic layer.

[0019] The liquid crystal display panel may further include an adhesion layer interposed between the antistatic layer and the protective film.

[0020] The liquid crystal display panel may further include a touch sensor formed between the first substrate and the second substrate.

[0021] In another exemplary embodiment, a method of manufacturing a liquid crystal display panel includes: providing a first substrate; providing a thin film transistor array comprising at least one thin film transistor formed on a first surface of the first substrate; providing a second substrate having a first surface facing the first substrate; assembling the first substrate and the second substrate and injecting liquid crystal molecules between the first surface of the first substrate and the first surface of the second substrate; and forming an antistatic layer comprising conductive nanowire at a surface opposite the first surface of the second substrate.

[0022] The step of forming the antistatic layer may include forming the antistatic layer by wet-coating solution including the conductive nanowire.

[0023] The conductive nanowire may include an electrically conductive material. The electrically conductive material may include at least one of gold (Au), silver (Ag), platinum (Pt), palladium (Pd), nickel (Ni), copper (Cu), carbon (C), aluminum (Al), tin (Sn), and titanium (Ti), or a combination of two or more of these materials.

[0024] The solution including the conductive nanowire may further include a polymer material.

[0025] The method of manufacturing the liquid crystal display may further include forming an overcoat layer on the antistatic layer.

[0026] The step of forming the overcoat layer may include wet-coating a synthetic resin on the antistatic layer; and hardening the synthetic resin coated on the antistatic layer.

[0027] The method of manufacturing the liquid crystal display may further include attaching a protective film on the antistatic layer.

[0028] The method of manufacturing the liquid crystal display may further include forming a touch sensor between the first substrate and the second substrate.

[0029] A better understanding of the above and many other features and advantages of this invention may be obtained from a consideration of the detailed description thereof below, particularly if such consideration is made in conjunction with the several views of the appended drawings, wherein like elements are referred to by like reference numerals throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] FIG. **1** is a perspective view of a first exemplary embodiment of an LCD panel according to the present invention;

[0031] FIG. **2** is a cross-sectional view of the LCD panel shown in FIG. **1**;

[0032] FIG. **3** is an enlarged view of the antistatic layer and the overcoat layer shown in FIG. **2**;

[0033] FIG. **4** is a scanning electron microscope (SEM) photograph of the antistatic layer shown in FIG. **3**;

[0034] FIG. **5** is a cross-sectional view of a second exemplary embodiment of an LCD panel according to the present invention;

[0035] FIG. **6** is an enlarged view of the antistatic layer and the protective film shown in FIG. **5**;

[0036] FIG. **7** is a cross-sectional view of a third exemplary embodiment of an LCD panel according to the present invention;

[0037] FIG. **8** is a cross-sectional view of a fourth exemplary embodiment of an LCD panel according to the present invention;

[0038] FIG. **9** is a cross-sectional view of a fifth exemplary embodiment of an LCD panel according to the present invention;

[0039] FIGS. **10**A, **10**B, and **10**C are cross-sectional views of an exemplary embodiment of a process of assembling a TFT substrate and an opposite substrate according to the present invention;

[0040] FIGS. **11**A and **11**B are cross-sectional views of an exemplary embodiment of a process of manufacturing an antistatic layer and an overcoat layer according to the present invention;

[0041] FIG. **12** is a cross-sectional view of another exemplary embodiment of a process of manufacturing the antistatic layer according to the present invention; and

[0042] FIG. **13** is a cross-sectional view of still another exemplary embodiment of a process of manufacturing the antistatic layer according to the present invention.

DETAILED DESCRIPTION

[0043] FIG. **1** is a perspective view of a first exemplary embodiment of an LCD panel according to the present invention, and FIG. **2** is a cross-sectional view of the LCD panel shown in FIG. **1**.

[0044] Referring to FIGS. **1** and **2**, an LCD panel **300** includes a thin film transistor ("TFT") substrate **100**, an opposite substrate **150** arranged opposite to the TFT substrate **100**, and liquid crystal molecules **155**.

[0045] The TFT substrate **100** includes a gate line **20**, a data line **30**, a gate insulating layer **40**, a TFT **50**, a common electrode **81**, a pixel electrode **83**, and a passivation layer **70**.

[0046] The gate line **20** receives a scan signal from a gate driver (not shown). The gate line **20** is formed on a first substrate **10** and formed in a single layer structure including molybdenum (Mo), chrome (Cr), silver (Ag) or tungsten (W) or in a multilayer structure using theses metals.

[0047] The data line **30** receives a pixel voltage signal from a data driver (not shown). The data line **30** crosses the gate line **20** with the gate insulating layer **40** disposed therebetween.

[0048] The gate insulating layer **40** is formed between the gate line **20** and the data line **30** and insulates a gate metal pattern including the gate line **20** from a data metal pattern including the data line **30**.

[0049] The TFT **50** causes the pixel voltage signal of the data line **30** to be charged in the pixel electrode **83** in response to the scan signal of the gate line **20**. The TFT **50** includes a gate electrode connected to the gate line **20**, a source electrode **53** connected to the data line **30**, and a drain electrode **55** connected to the pixel electrode **83**.

[0050] The TFT **50** includes a semiconductor pattern **60** forming a channel between the source electrode **53** and the drain electrode **55**. The semiconductor pattern **60** includes an active layer **61** and an ohmic contact layer **63**. The active layer **61** overlaps the gate electrode **51** with the gate insulating layer **40** disposed therebetween. The ohmic contact layer **63** is formed on the active layer **61** and forms an ohmic contact between the data line **30** and the source electrode **53**, and between the data line **30** and the drain electrode **55**.

[0051] The common electrode **81** supplies a reference voltage for driving the liquid crystal molecules **155**, i.e., a common voltage to the liquid crystal molecules **155**. The common electrode **81** may be formed of a transparent electrode on the first substrate **10**.

[0052] The pixel electrode **83** is connected to the drain electrode **55** of the TFT **50** and overlaps the common electrode **81** with the gate insulating layer **40** and the passivation layer **70** disposed therebetween. A plurality of slits is formed on the pixel electrode **83** to form the fringe electric field with the common electrode **81**. The pixel electrode **83** forms the fringe electric field with the common electrode **81** upon receipt of the pixel voltage signal through the TFT **50**, thereby twisting the liquid crystal molecules **155** arranged in a horizontal direction by dielectric anisotropy.

[0053] The passivation layer **70** is formed on the data line **30** and the TFT **50** to protect the data line **30** and the TFT **50**. The passivation layer **70** includes a contact hole **85** through which the pixel electrode **83** is connected to the drain electrode **55**.

[0054] The opposite substrate **150** includes a black matrix **120**, a color filter **130**, an antistatic layer **160**, and an overcoat layer **170**. The black matrix **120** is formed on a second substrate **110** in a matrix shape to divide a region where the color filter **130** is to be formed. The black matrix **120** overlaps the gate line **20**, the data line **30**, and the TFT **50** of the TFT substrate **100**.

[0055] The color filter **130** is formed in a region divided by the black matrix **120**. The color filter **130** includes red (R), green (G), and blue (B) color filters to express video images. The color filter **130** is formed in a stripe shape in which R, G and B color filters are arranged in a row.

[0056] The antistatic layer **160** is formed at a back side **115** of the second substrate **110**, the second substrate **110** facing the TFT substrate **100**. In an exemplary embodiment, the antistatic layer **160** is formed of a transparent conductive layer.

[0057] The overcoat layer **170** is formed on the antistatic layer **160**.

[0058] The liquid crystal molecules **155** are formed of materials having dielectric anisotropy and refractive anisotropy. The liquid crystal molecules **155** are arranged in a horizontal direction by a horizontal electric field between the common electrode **81** and the pixel electrode **83** of the TFT substrate **100**.

[0059] Hereinafter, the antistatic layer **160** and the overcoat layer **170** are described in detail with reference to FIGS. **3** and **4**.

[0060] FIG. **3** is an enlarged diagram of the antistatic layer and the overcoat layer shown in FIG. **2**, and FIG. **4** is a scanning electron microscope (SEM) photograph of the antistatic layer shown in FIG. **3**.

[0061] Referring to FIG. **3**, the antistatic layer **160** is formed by coating an aqueous solution including a conductive nanowire **165**. The conductive nanowire **165** may be formed of an electrically conductive material. For example, the electrically conductive material may be one of gold (Au), silver (Ag), platinum (Pt), palladium (Pd), nickel (Ni), copper (Cu), carbon (C), aluminum (Al), tin (Sn), and titanium (Ti), or a combination of theses metals. In an exemplary embodiment, the electrically conductive material is formed of Ag. The conductive nanowire **165** may be formed to a diameter thickness_of about 20 nm to about 40 nm and with a length of about 5 μm to about 10 μm as shown in FIG. **4**.

[0062] In an exemplary embodiment, the surface resistivity of the antistatic layer **160** may be 500 Ω/sq or less. Because the surface resistivity of the antistatic layer **160** becomes less than the surface resistivity, 1 kΩ/sq, of an indium tin oxide (ITO) layer which has been conventionally used as an antistatic layer, the antistatic effect of the antistatic layer **160** is improved.

[0063] The overcoat layer **170** is formed on the antistatic layer **160**. The overcoat layer **170** serves as a protective layer and planarizes the antistatic layer **160** having a rugged surface and also protects the antistatic layer **160** from scratching.

[0064] The overcoat layer **170** may be formed of a transparent synthetic resin. More specifically, the overcoat layer **170** may be formed of at least one of polymethylmethacrylate (PMMA), polyamide (PA), polyurethane resin (PUR), and epoxy resin.

[0065] In an exemplary embodiment, the overcoat layer **170** has a thickness d1 of about 1 nm to about 10 μm. When the thickness d1 of the overcoat layer **170** is less than about 1 nm, the overcoat layer **170** may not sufficiently cover the antistatic layer **160**. When the thickness d1 of the overcoat layer **170** is greater than about 10 μm, the overcoat layer **170** covers the antistatic layer **160** but may cause the deformation of the second substrate **110** during thermal processing due to the very thick overcoat layer.

[0066] FIG. **5** is a cross-sectional view of a second exemplary embodiment of an LCD panel according to the present invention.

[0067] Referring to FIG. **5**, an LCD panel **400** includes a TFT substrate **100**, an opposite substrate **150** arranged opposite to the TFT substrate **100**, and liquid crystal molecules (not shown).

[0068] The opposite substrate **150** includes a second substrate **110**, a black matrix **120**, a color filter **130**, an antistatic layer **160**, and a protective film **175**.

[0069] The antistatic layer **160** is formed at the back of the second substrate **110** facing the TFT substrate **100** and the protective film **175** is arranged on the antistatic layer **160**.

[0070] The black matrix **120** is formed on the second substrate **110** in a matrix shape to divide a region where the color filter **130** is to be formed.

[0071] The color filter **130** is formed in a region divided by the black matrix **120**. The color filter **130** includes red (R), green (G), and blue (B) color filters to achieve video images.

[0072] The liquid crystal molecules **155** are arranged in a horizontal direction by a horizontal electric field between a common electrode **81** and a pixel electrode **83** of the TFT substrate **100**.

[0073] The TFT substrate **100** includes a gate line **20** formed on a first substrate **10**, a data line **30** crossing the gate line **20** with the gate insulating layer **40** disposed therebetween, and a TFT **50** connected to the gate line **20** and the data line **30**. The TFT substrate **100** also includes a pixel electrode **83**, and a common electrode **81** overlapping the pixel electrode **83** with the gate insulating layer **40** and the passivation layer **70** disposed therebetween.

[0074] Hereinafter, the antistatic layer **160** and the protective film **175** are described in detail with reference to FIG. **6**.

[0075] FIG. **6** is an enlarged diagram of the antistatic layer **160** and the protective film **175**, as shown in FIG. **5**.

[0076] Referring to FIG. **6**, the antistatic layer **160** is formed of a conductive nanowire **165**. The conductive nanowire **165** may be formed of an electrically conductive material. In an exemplary embodiment, the electrically conductive material is formed of Ag. The surface resistivity of the antistatic layer **160** may be 500 Ω/sq or less.

[0077] The protective film **175** is formed on the antistatic layer **160**. The protective film **175** may be formed of a resin such as polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polycarbonate (PC) or polyether sulfone (PES). The protective film **175** protects the antistatic layer **160** from scratching, thereby reducing a defect rate of the LCD panel **300**.

[0078] An adhesion layer **173** may be formed under the protective film **175**. The adhesion layer **173** planarizes the antistatic layer **160** having a rugged surface due to the conductive nanowire **165**. In an exemplary embodiment, the adhesion layer **173** has a thickness d2 of 15 μm or more. When the thickness d2 of the overcoat layer **170** is less than 15 μm, the adhesion layer **173** may not planarize the antistatic layer **160** having a rugged surface.

[0079] FIG. **7** is a cross-sectional view of a third exemplary embodiment of an LCD panel according to the present invention.

[0080] Referring to FIG. **7**, an LCD panel **500** includes a TFT substrate **100**, an opposite substrate **150** arranged opposite to the TFT substrate **100**, and liquid crystal molecules (not shown).

[0081] The opposite substrate **150** includes a second substrate **110**, a black matrix **120**, a color filter **130**, an antistatic layer **160**, and a protective film **175**.

[0082] The antistatic layer **160** is formed at the back of the second substrate **110** facing the TFT substrate **100** and the protective film **175** is arranged on the antistatic layer **160**.

[0083] The antistatic layer **160** is formed of a conductive nanowire **165** and a polymer material. More specifically, the antistatic layer **160** is formed by adding an aqueous polymer material to an aqueous solution including a conductive nanowire **165**. The aqueous polymer material may be at least one of poly(3,4-etylenedioxythiophene) and water-dispersive emulsion. The water-dispersive emulsion includes water-dispersive urethane, water-dispersive polyurethane, and the like.

[0084] Because the antistatic layer **160** includes a polymer material that increases an adhesion force with the second substrate **110**, the surface resistivity is lowered, thereby improving the antistatic processing effect of the antistatic layer **160**. In an exemplary embodiment, the conductive nanowire **165** is formed of an electrically conductive material, for example, Ag.

[0085] The protective film **175** is formed on the antistatic layer **160** to protect the antistatic layer **160** from scratching. Since the protective film **175** has been explained with reference to the second exemplary embodiment of the present invention, a detailed description thereof will not be repeated. Instead of the protective film **175**, the overcoat layer **170** described with reference to the first exemplary embodiment of the present invention may be formed on the antistatic layer **160**.

[0086] The black matrix **120** is formed on a second substrate **110** to divide a region where the color filter **130** is to be formed. The color filter **130** includes red (R), green (G) and blue (B) color filters to represent video images.

[0087] The liquid crystal molecules are arranged in a horizontal direction by a horizontal electric field between a common electrode **81** and a pixel electrode **83** of the TFT substrate **100**.

[0088] The TFT substrate **100** includes a first substrate **10**, a gate line **20**, a gate insulating layer **40**, a data line **30**, a TFT **50**, the common electrode **81**, the pixel electrode **83**, and a passivation layer **70**. The TFT substrate **100** has the same configuration as that of FIGS. **1** and **2** and thus a detailed description thereof will be omitted.

[0089] FIG. **8** is a cross-sectional view of a fourth exemplary embodiment of an LCD panel according to the present invention.

[0090] Referring to FIG. **8**, an LCD panel **600** includes a TFT substrate **100**, an opposite substrate **150** arranged opposite to the TFT substrate **100**, liquid crystal molecules (not shown), a column spacer **190**, and a touch sensor **200**. The touch sensor **200** includes a touch spacer **193** and a sensor **195**.

[0091] The opposite substrate **150** includes a second substrate **110**, an antistatic layer **160**, an overcoat layer **170**, a touch spacer **193**, a black matrix **120**, a color filter **130**, and a common electrode **81**.

[0092] The antistatic layer **160** is formed at the back side of the second substrate **110** and formed of a conductive nanowire **165**. The conductive nanowire **165** may be formed of an electrically conductive material. The overcoat layer **170** is formed on the antistatic layer **160** to protect the antistatic layer **160** from scratching.

[0093] Although the antistatic layer **160** including the conductive nanowire **165**, along with the overcoat layer **170** have been described, the protective film **175** along with adhesion layer **173** described with reference to the second and third exemplary embodiments of the present invention may be formed on the antistatic layer **160** rather than on the overcoat layer **170**.

[0094] The touch spacer **193** may be formed on the black matrix **120**.

[0095] The black matrix **120** is formed on a second substrate **110** to divide a region where the color filter **130** is to be formed. The color filter **130** includes red (R), green (G), and blue (B) color filters to achieve video images.

[0096] The common electrode **81** is formed to cover the color filter **130** and the touch spacer **193**. When pressure is applied from the exterior, the common electrode **81** covering the touch spacer **193** contacts the sensor **195** formed on the TFT substrate **100** so that external inputs can be detected.

[0097] The TFT substrate **100** includes a gate line **20** formed on a first substrate **10**, a data line **30** overlapping the gate line **20** with a gate insulating layer **40** disposed therebetween, and a TFT **50** overlapping the gate line **20** and the data line **30**. The TFT substrate **100** also includes a pixel electrode **83** connected to the TFT **50**.

[0098] The TFT substrate **100** overlaps the TFT **50** and includes the sensor **195** formed on a passivation layer **70**. The sensor **195** faces the touch spacer **193** of the opposite substrate **150** and is spaced apart from the touch spacer **193** until pressure is applied.

[0099] The liquid crystal molecules are formed of materials having dielectric anisotropy and refractive anisotropy. The liquid crystal molecules are formed between the opposite substrate **150** and the TFT substrate **100**.

[0100] The column spacer **190** is formed between the TFT substrate **100** and the opposite substrate **150**. The column spacer **190** separates the TFT substrate **100** from the opposite substrate **150** until pressure is applied from the exterior.

[0101] FIG. **9** is a cross-sectional view of a fifth exemplary embodiment of an LCD panel according to the present invention.

[0102] Referring to FIG. **9**, an LCD panel **700** includes a TFT substrate **100**, an opposite substrate **150** arranged opposite to the TFT substrate **100**, and liquid crystal molecules (not shown).

[0103] The opposite substrate **150** includes a second substrate **110**, an auxiliary substrate **113**, an antistatic layer **160**, an overcoat layer **170**, a black matrix **120**, a color filter **130**, a common electrode **81**, and a touch sensor **200**.

[0104] The antistatic layer **160** is formed at the back side of the second substrate **110** facing the TFT substrate **100**. The antistatic layer **160** is formed of a conductive nanowire **165**.

[0105] The overcoat layer **170** is formed on the antistatic layer **160**. The overcoat layer **170** planarizes the antistatic layer **160** having a rugged surface.

[0106] The antistatic layer **160** and the overcoat layer **170** have the same configuration as the antistatic layer **160** and the overcoat layer **170** described in the first exemplary embodiment of the present invention and thus a detailed description thereof will be omitted.

[0107] Although the antistatic layer **160** including the conductive nanowire **165** and the overcoat layer **170** have been described, the protective film **175** along with the adhesion layer **173** described in the second and third exemplary embodiments of the present invention may be formed on the antistatic layer **160**.

[0108] The touch sensor **200** includes a touch spacer **220**, a first sensor electrode **210**, and a second sensor electrode **230**.

[0109] The first and second sensor electrodes **210** and **230** face the auxiliary substrate **113** and the second substrate **110**, respectively. When pressure is applied from the exterior, the first and second sensor electrodes **210** and **230** contact each other so that external inputs can be sensed.

[0110] The touch spacer **220** is formed on the first sensor electrode **210**. Alternatively, the touch sensor **220** may be formed on the second sensor electrode **230**. The touch spacer **220** maintains a prescribed distance between the first and second sensor electrodes **210** and **230** when pressure is applied from the exterior.

[0111] The black matrix **120** is formed on the auxiliary substrate **113** and divides a region where the color filter **130** is to be formed. The color filter **130** represents a video image. The common electrode **81** is formed to cover the black matrix **120** and the color filter **130**.

[0112] The TFT substrate **100** includes a gate line **20** formed on a first substrate **10**, a data line **30** overlapping the gate line **20** with a gate insulating layer **40** disposed therebetween, and a TFT **50** overlapping the gate line **20** and the data line **30**. The TFT substrate **100** also includes a pixel electrode **83** connected to the TFT **50** with a passivation layer **70** disposed therebetween.

[0113] The liquid crystal molecules are formed between the opposite substrate **150** and the TFT substrate **100**.

[0114] In the first to fifth exemplary embodiments of the present invention, the color filter has been described as being formed on the opposite substrate but the color filter may be formed on the TFT substrate.

[0115] A process of manufacturing an LCD panel will be described hereinafter with reference to FIGS. **10**A to **13**.

[0116] FIGS. **10**A, **10**B, and **10**C are cross-sectional views of an exemplary embodiment of a process of assembling a TFT substrate and an opposite substrate in the process of manufacturing the LCD panel according to the present invention.

[0117] Referring to FIG. **10**A, a TFT substrate **100** including a TFT array formed on a first substrate **10** is prepared. A gate metal pattern including a gate line **20** and the gate electrode **51** is formed on the first substrate **10** and a common electrode **81** is formed on the first substrate **10**. A gate insulating layer **40** is formed on the gate metal pattern and the common electrode **81**, and a data metal pattern is formed including a data line **30**, a source electrode **53**, and a drain electrode **55**. Next, passivation layer **70** including a contact hole **85** is formed on the data metal pattern and a pixel electrode **83** is formed on the passivation layer **70**. Although not shown in the drawing, a touch sensor may be formed on the TFT substrate **100**.

[0118] Referring to FIG. **10**B, an opposite substrate **150** is prepared including a color filter array formed on a second substrate **110**. A black matrix **120** is formed on the second substrate **110**. A color filter **130** is formed in a region divided by the black matrix **120**.

[0119] Although not shown in the drawing, a touch sensor may be formed at the back side of the second substrate **110** on which the color filter array is formed.

[0120] Referring to FIG. **10**C, the TFT substrate **100** and the opposite substrate **150** are assembled together and liquid crystal molecules **155** are injected between the TFT substrate **100** and the opposite substrate **150**.

[0121] FIGS. **11**A and **11**B are cross-sectional views of an exemplary embodiment of a process of manufacturing an antistatic layer and an overcoat layer according to the present invention.

[0122] Referring to FIG. **11**A, an antistatic layer **160** is formed at the back side of a second substrate **110**. More specifically, an aqueous solution including a conductive nanowire **165** is coated by wet coating such as spin coating, bar coating or slit coating on the back side of the second substrate **110** facing the TFT substrate **100**.

[0123] Referring to FIG. **11**B, the overcoat layer **170** is formed on the antistatic layer **160**. More specifically, a synthetic resin is coated by wet coating such as spin coating, bar coating or slit coating on the antistatic layer **160**. Thereafter, the synthetic resin is hardened by using heat or ultraviolet rays. Then the antistatic layer **160** and the overcoat layer **170** are formed at the back side of the second substrate **110**. Since an identical wet coating device is used for the antistatic layer **160** and the overcoat layer **170**, manufacturing costs can be saved.

[0124] FIG. **12** is a cross-sectional view of another exemplary embodiment of a process of manufacturing an antistatic layer according to the present invention.

[0125] Referring to FIG. **12**, an antistatic layer **160** and a protective film **175** are formed at the back side of the second substrate **110**. The antistatic layer **160** is formed by coating an aqueous solution including a conductive nanowire **165** by wet coating at the back side of the second substrate **110**. Thereafter, the protective film **175** including an adhesion layer is attached to the antistatic layer **160**.

[0126] FIG. **13** is a cross-sectional view of another exemplary embodiment of a process of manufacturing an antistatic layer according to the present invention.

[0127] Referring to FIG. **13**, an antistatic layer **160** and a protective film **175** are formed at the back side of a second substrate **110**. The antistatic layer **160** is formed by coating an aqueous solution including a conductive nanowire **165** and a polymer material at the back side of the second substrate **110** by wet coating. Next, a protective film **175** is attached to an antistatic layer **160** to protect the antistatic layer **160** from external shock or scratching. As a result, the antistatic layer **160** and the protective film **175** are formed at the back of the second substrate **110**.

[0128] Although the antistatic layer **160** has been described as being formed after the TFT substrate **100** and the opposite substrate **150** have been assembled, the present invention is not limited thereto and the antistatic layer **160** may be formed before the TFT substrate **100** and the opposite substrate **150** are assembled.

[0129] As described above, an LCD panel and a method of manufacturing the LCD panel according to the present invention can save manufacturing costs by forming the antistatic layer using a conductive nanowire. Further, an LCD panel and a method of manufacturing the LCD panel according to the present invention can protect the antistatic layer from scratching by forming an overcoat layer or a protective film on the antistatic layer, thereby reducing a defect rate of the LCD panel.

[0130] As will by now be evident to persons of skill in this art, many modifications, substitutions and variations can be made in and to the materials, components, configurations and methods of implementation of the LCD panels and methods for manufacturing them of the present invention without departing from its spirit and scope. Accordingly, the scope of the present invention should not be limited to the particular embodiments illustrated and described herein, as they are merely exemplary in nature, but rather, should be fully commensurate with that of the claims appended hereafter and their functional equivalents.

What is claimed is:

1. A liquid crystal display panel, comprising:

a first substrate;

a thin film transistor array comprising at least one thin film transistor formed on a first surface of the first substrate;

a second substrate comprising a first surface facing the first substrate, the second substrate comprising an antistatic layer on a surface opposite the first surface of the second substrate; and

liquid crystal molecules positioned between the first surface of the first substrate and the first surface of the second substrate, wherein the antistatic layer comprises conductive nanowire.

2. The liquid crystal display panel of claim 1, wherein the conductive nanowire is comprised of an electrically conductive material.

3. The liquid crystal display panel of claim 2, the electrically conductive material comprising at least one of gold (Au), silver (Ag), platinum (Pt), palladium (Pd), nickel (Ni), copper (Cu), carbon (C), aluminum (Al), tin (Sn), and titanium (Ti), or a combination of two or more of these materials.

4. The liquid crystal display panel of claim 1, further comprising an overcoat layer formed on the antistatic layer.

5. The liquid crystal display panel of claim 4, wherein the overcoat layer is formed with a thickness of about 1 nm to about 10 μm.

6. The liquid crystal display panel of claim 4, wherein the overcoat layer is formed of a transparent synthetic resin.

7. The liquid crystal display panel of claim 1, wherein the antistatic layer further comprises a polymer material.

8. The liquid crystal display panel of claim 7, wherein the polymer material is an aqueous polymer material.

9. The liquid crystal display panel of claim 8, the aqueous polymer material comprising at least one of poly(3,4-etylenedioxythiophene), water-dispersive urethane and water-dispersive polyurethane.

10. The liquid crystal display panel of claim 1, further comprising a protective film on the antistatic layer.

11. The liquid crystal display panel of claim 11, further comprising an adhesion layer interposed between the antistatic layer and the protective film.

12. The liquid crystal display panel of claim 1, further comprising a touch sensor formed between the first substrate and the second substrate.

13. A method of manufacturing a liquid crystal display panel, the method comprising:

providing a first substrate;

providing a thin film transistor array comprising at least one thin film transistor formed on a first surface of the first substrate;

providing a second substrate comprising a first surface facing the first substrate;

assembling the first substrate and the second substrate and injecting liquid crystal molecules between the first surface of the first substrate and the first surface of the second substrate; and

forming an antistatic layer comprising conductive nanowire at a surface opposite the first surface of the second substrate.

14. The method of claim 13, wherein forming the antistatic layer comprises forming the antistatic layer by wet-coating solution comprising the conductive nanowire.

15. The method of claim 13, wherein the conductive nanowire comprises an electrically conductive material.

16. The method of claim 15, the electrically conductive material comprising at least one of gold (Au), silver (Ag), platinum (Pt), palladium (Pd), nickel (Ni), copper (Cu), carbon (C), aluminum (Al), tin (Sn), and titanium (Ti), or a combination of two or more of these materials.

17. The method of claim 14, wherein the solution comprising the conductive nanowire further comprises a polymer material.

18. The method of claim 13, further comprising forming an overcoat layer on the antistatic layer.

19. The method of claim 18, wherein forming the overcoat layer comprises:

wet-coating a synthetic resin on the antistatic layer; and

hardening the synthetic resin coated on the antistatic layer.

20. The method of claim 13, further comprising attaching a protective film on the antistatic layer.

21. The method of claim 13, further comprising forming a touch sensor between the first substrate and the second substrate.

* * * * *

patsnap

专利名称(译)	液晶显示面板及其制造方法		
公开(公告)号	US20090051842A1	公开(公告)日	2009-02-26
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摘要(译)

本发明公开了一种液晶显示面板，包括：第一基板;薄膜晶体管阵列，包括形成在第一基板的第一表面上的至少一个薄膜晶体管;以及第二基板，具有面向第一基板的第一表面，第二基板在与第二基板的第一表面相对的表面上包括抗静电层的基板。液晶分子位于第一基板的第一表面和第二基板的第一表面之间，其中抗静电层包括导电纳米线。